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(54) Abstract Title
Thermostatic mixing valve

(57) A thermostatic mixing valve has a hollow body 10 with hot and cold water inlets 11, 12 and a mixed water outlet, 17. The mixing chamber 13 has an annular closure member 15 which may seal against either of seats 26 or 27 to close the hot or cold water inlets. The seat 26 comprises a plastic ring and the seat 27 is made of rubber. A thermostatic actuator 16 moves the closure member 15 in the chamber 13 in response to changes in the water temperature to maintain the outlet water at a predetermined temperature. A sleeve member 31 surrounds the bulb 18 of the thermostatic actuator 16 and forms a tubular pathway to the outlet. Radial openings 33 allow the passage of mixed water from the mixing chamber 13 to the outlet and by separating the flow into a plurality of flows enhance the sensitivity of the valve. The radial passages may be formed by projections (30', fig. 2) at the end of the sleeve. As the total stroke of the closure member 15 is between 0.5mm and 0.8mm, the response time of the valve is very quick.

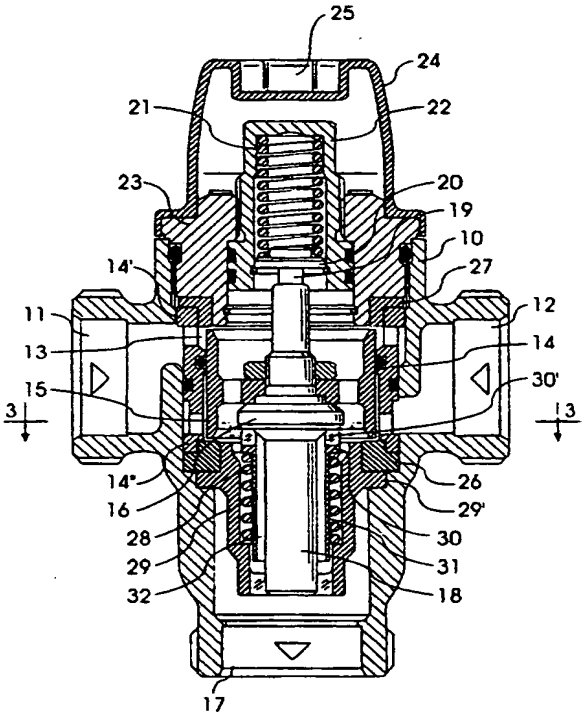

Fig. 1

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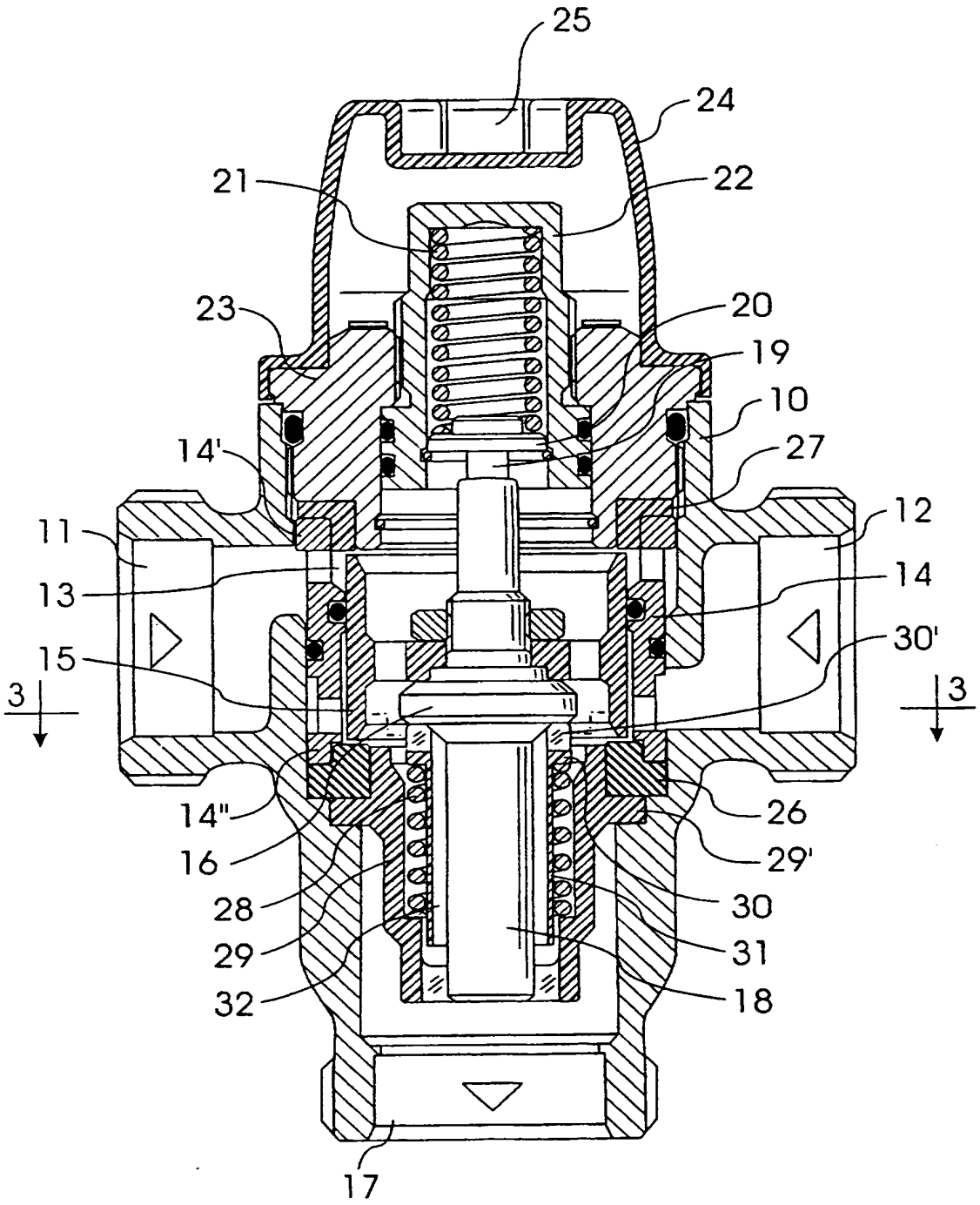
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Fig. 1

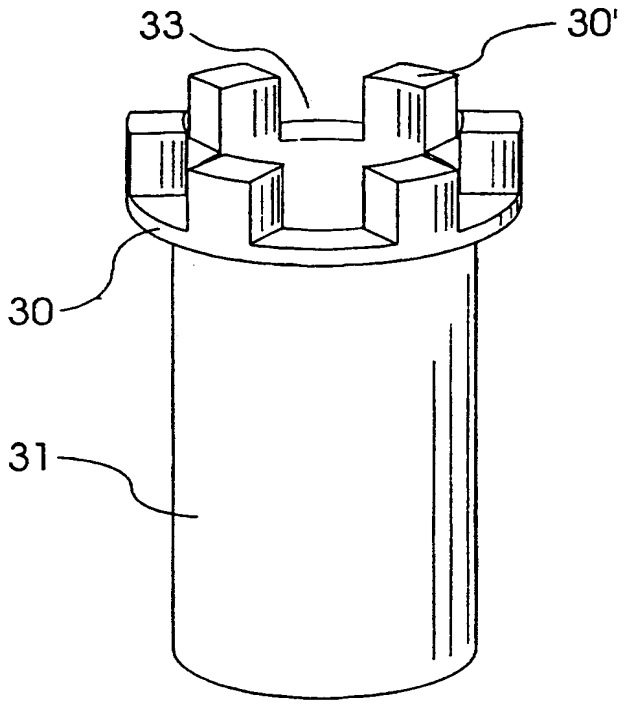

Fig. 2

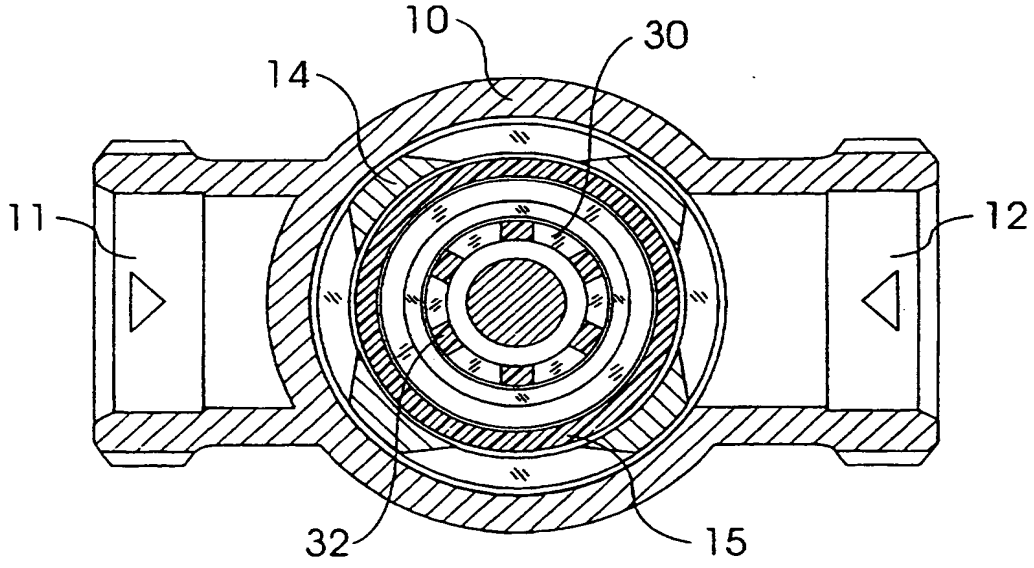

Fig. 3

THERMOSTATIC MIXING VALVE

The present invention relates to a thermostatic mixing valve. The present invention has particular application to a thermostatic mixing valve for sanitary water, usually used for mixing the hot water coming from a storage tank or a central source, for example a water-heater or a boiler, with the cold water coming from the usual water distribution network, in order to supply mixed water, at a pre-fixed temperature, to a sole user or to several delivery points.

Thermostatic mixing valves of this general type are known for example from WO-A-90/06465 and EP-A-0767332.

Mixers of the above mentioned type generally comprise an adjustable thermostatic actuator which provides for keeping the temperature of the mixed water at a pre-set constant value, independently from the temperature variations of the hot and/or the cold water. Moreover, the actuator provides for completely stopping the flow of hot water for example when there is an interruption of the cold water from the water supply network or anomalous working conditions of the same mixing valve occur.

Mixing valves of this kind are advantageously used in plants for the distribution of sanitary hot water to one or more users. Said valves should operate immediately to control the temperature of the mixed water, keeping the same under a safety value. However, more and more restrictive regulations require extremely rapid operations with times evaluated in the range of few seconds or even less, in order to avoid the situation where, in the absence of cold water, handicapped people or others with insufficient motor capabilities may unexpectedly come into contact with how water at high temperature.

In general, thermostatic valves of this type not only should keep the mixed water temperature within a very limited temperature range, or automatically and rapidly close the hot water flow in the absence of cold water, but they should also provide for an efficient seal in such a way that water seepage be extremely limited and does not exceed for example 0.25 litres in the first 30 seconds.

Moreover, it is required that variations in pressure and/or flow of hot and cold water do not cause substantial variations in the mixed water conditions, the temperature of which is to be kept constant in a limited range of values.

Therefore, a general object of the invention is to provide for a thermostatic mixing valve which rapidly closes the hot water inlet and which has a high sensitivity to variations in the mixed water temperature.

A further object of the present invention is to provide for a thermostatic mixing valve which is able to control the temperature of the mixed water in a very limited range of values, at the variation in both the pressures and flow rates of the hot and cold water to be mixed.

According to the present invention, there is provided a thermostatic mixing valve, the mixing valve comprising: a hollow body having an inlet for cold water, an inlet for hot water, and an outlet for mixed water in fluid communication with a mixing chamber, the cold and hot water inlets opening laterally towards the mixing chamber in axially spaced positions; a guide cage inside the mixing chamber and an annular closing member axially slidable in the guiding cage between a retracted position against a first sealing seat where it closes the hot water inlet and an advanced position against

a second sealing seat where it closes the cold water inlet; an axially extending thermostatic actuator and biasing means oppositely acting on the closing member, said thermostatic actuator having a sensitive bulb extending in a path for the mixed water and acting to move said closing member towards one of said sealing seats to keep the mixed water temperature at a constant value when the water conditions at the cold and/or hot water inlets vary and for closing the hot water inlet in the absence of the cold water flow; the sensitive bulb of the thermostatic actuator being surrounded by a sleeve member of larger diameter defining a tubular path which extends coaxially with the actuator bulb for conveying mixed water from the mixing chamber towards the water outlet; said sleeve member being movably supported with the thermostatic actuator and the closing member; said sleeve member comprising a set of radial passages to sub-divide the mixed water flow into a plurality of separated flows between the mixing chamber and said tubular path.

According to a preferred embodiment of the invention, the radial passages for the mixed water are provided at one end of the water conveying sleeve, in correspondence to the sealing seat for the hot water, said passages being provided by a plurality of spaced apart projections, circumferentially arranged at the end facing the mixing chamber of the water conveying sleeve.

The thermal exchange conditions between the mixed water and the control thermostatic actuator are improved, the stroke of the closing member at very low values is reduced, and a particular sub-division of the water flow at the outlet of the mixing chamber is provided in such a way to automatically compensate for possible flow and pressure variations of the hot and/or cold water flowing at the mixing valve.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of an example of a mixing valve according to the present invention;

Fig. 2 is a perspective view of an example of a conveying sleeve for the mixed water flow;

Fig. 3 is a cross-sectional view along line 3-3 of Fig. 1.

As shown in the various Figures, the thermostatic mixing valve according to the invention substantially comprises a metal body 10 provided with an inlet 11 for the cold water and an inlet 12 for the hot water, both laterally opening in axially spaced apart positions toward the mixing chamber 13. A cylindrical cage 14 defining the mixing chamber 13 is sealingly disposed inside the body 10 of the valve and is provided with radial passages at both ends to communicate said mixing chamber 13 at axially spaced apart positions with the hot and cold water inlets 11 and 12. An annular closing member 15 reciprocates and is guided inside the cage 14 to selectively close and open the water inlet passages as explained further on. For this purpose, the closing member 15 is connected to an axially extending thermostatic actuator, for example of the wax type, wholly indicated by reference number 16, having a thermosensitive bulb 18 which coaxially extends to an outlet 17 for the mixed water.

The thermostatic actuator 16, in a known way, has a sliding stem 19 resting against a piston member 20 which is biased towards the mixing chamber 13 by a first, extra-stroke, spring 21 inside a hollow cup 22 threaded into a

hole of a plug 23 which closes the body 10 of the valve at the upper side. The cup 22 may be manually actuated to vary the pushing force exerted by a second spring 28 acting on the thermostatic actuator 16 to reciprocate the closing member 15 to vary the temperature setting of the actuator 16 and therefore the temperature of the mixed water. A removable protection cover 24 is provided with an outer hexagonal seat 25 by which it is possible to engage the hexagonal end of the cup member 22 to rotate the same.

The closing member 15, under the action of the thermostatic actuator 16 and the second counteracting spring 28, is therefore movable or reciprocable between a retracted position against a first sealing seat in the form of a ring member 26, in which it closes the hot water inlet 12, and an advanced position against a second sealing seat or ring member 27, where it closes the cold water inlet 11. In this regard, the movement of the closing member 15 downwardly or towards the first seat 26, caused by the axial extension of the thermostatic actuator 16, is opposed by the second biasing spring 28. The bottom end of the second spring 28 rests against an annular shoulder inside a tubular member 29 having a flange portion 29' resting against an annular shoulder inside the body 10 and the top end of the spring 28 rests against an annular flange 30 at an end of a sleeve 31 which conveys the mixed water flow. As shown in Figure 1, the sleeve 31 surrounds and axially extends along the sensitive bulb 18 of the thermostatic actuator 16 and has a greater diameter to define a tubular path 32 for conveying the mixed water from the mixing chamber 13 toward the outlet 17.

As shown in Figure 1, the upper sealing seat 27 for the closing member 15 is provided by a ring member in plastics material having an outwardly protruding peripheral rim which is locked in position between an upper ring 14' of the cage

14 for the closing member and a corresponding shoulder in the closing plug 23.

The sealing seat 26 relating to the hot water inlet 12 is provided by a rubber gasket which is locked among a lower ring 14" of the cage 14 for the closing member, a radially outwardly extending flange 29' of the tubular member 29 supporting the biasing spring 28, and an annular shoulder inside the same body 10 of the valve. Therefore the gasket 26 is entirely surrounded by support surfaces which prevent deformation, leaving free the upper face only, against which the lower edge of the closing member 15 sealingly closes.

The use of a sealing seat 27 in plastics material for the cold water inlet 11 together with the use of plastics material for the same closing member 15 contributes to improve the sealing as it prevents limescale formation and deposit. Conversely, the use of a rubber gasket for the sealing seat 26 in correspondence to the hot water inlet, allows for a perfect watertight fit, thus avoiding any seepage. In addition, enclosing the rubber gasket 26 entirely by surrounding the same with supporting surfaces, except for the upper face, avoids the same gasket 26 from deforming, co-operating in this way to improve the sealing conditions.

In order to obtain a fast closing of the hot water inlet 12, with respect to known thermostatic valves, the stroke of the closing member 15 is extremely short, for example between 0.5-0.8 mm, in such a way to obtain extremely rapid intervention times, in the range of some seconds or less, depending on the water temperature controlled by the thermostatic actuator 16.

In order to increase the thermostatic actuator sensitivity, the bulb 18 preferably has a quite extended

cylindrical shape, having a slenderness ratio between the length and the diameter equal to or greater than 3.

Lastly, to increase the valve sensitivity to the variations in pressure and/or flow of the cold and hot water, the mixing chamber 13 is connected to the tubular path 32 provided for conveying the mixed water flow between the sleeve 31 and the sensitive bulb 18 by a set of radial passages 33 defined for example by projections 30' circumferentially arranged and angularly spaced apart at one end of the sleeve 31 which is facing the mixing chamber 13. In this way, the mixed water flow coming from the chamber 13 is initially subdivided into a plurality of separated flows which successively gather again in the sleeve 31 to form a tubular flow of mixed water running the sleeve 31 toward outlet 17.

The shape of the sleeve 31 is shown in the view of Figure 2. As can be seen, the sleeve 31 comprises a lower tubular portion and an upper flange 30 provided with cubic projections 30' defining said radial passages 33 and causing the whole sleeve to have the shape of a tower with "battlements" or "castellations".

From tests carried out, it has been verified that a good adjustment of the variations in pressure and/or flow of hot and cold water is obtained when the total cross-section of the radial passages between projections 30' is substantially equal to the annular passage of the mixed water flow existing between the sleeve 31 and the bulb 18 of the thermostatic actuator 16. For example, the total cross-section of the radial passages can be in a range which is within ±10-15% of the cross-sectional area of the annular passage of the sleeve 31.

The tests were carried out on the basis of existing regulations, which provide for a temperature of 15°C for the cold water, a temperature of 57°C for the hot water and a temperature of 41°C for the mixed water, with reaction times of the thermostatic element of some tenths of seconds, for example 0.25 seconds with a top-value temperature equal to or higher than 10°C, or with intervention times not exceeding a few seconds, for example 2.5 seconds, for temperature differences lower than 10°C, with respect to the required temperature of 41°C of the mixed water.

All the tests gave positive results as the detected parameters were largely included in those provided for by the existing regulations. For example, a time of 0.5 seconds for closing the hot water was achieved, with no seepage.

During the tests it has been found that differences of a few degrees sensed by the thermostatic sensing means caused the sudden closure of the hot water inlet, thus assuring a perfect watertight sealing.

The operation of the thermostatic valve is briefly as follows:

The valve is initially set for a pre-fixed value of the mixed water temperature, using the cover 24 on the adjusting cup 22.

The equilibrium condition of the closing member 15 is shown in Figure 1 where it can be seen that the cold water flow at inlet 11 enters the upper part of the chamber 13 and passes through the upper holes of the cage 14 to mix in the lower part of the chamber 13 with the hot water coming from inlet 12. The partially mixed water is then subdivided in a plurality of radial flows which enter the tubular path 32

defined by the sleeve 31 and by the sensitive bulb 18 flushing the whole surface. The water then flows towards the outlet 17.

As long as the mixed water temperature, sensed by bulb 18, is equal to the set value of the valve, the closing member 15 remains standing in the position shown in Figure 1. As soon as there is a variation in the temperature of the cold and/or hot water, or a variation in the flow rate or pressure at the two inlets 11 and 12, and consequently a variation in the mixed water temperature occurs, the system reacts immediately by moving the closing member 15 towards one sealing seat or the other one in such a way as to maintain the temperature of the mixed water at the desired value.

If a strong reduction or a total interruption in the cold water flow occurs, the thermostatic actuator 16 will sense the temperature of the hot water only and immediately react in a very short time to move the closing member 15 against the rubber gasket 26. In view of the short stroke of the closing member 15 and the particular arrangement of the thermostatic actuator 16, the thermostatic bulb 18 of which is positioned in the vicinity of or close to the hot water inlet 12, the reaction and closing time of the valve will be extremely short, thus avoiding the delivery of a water flow at a high temperature; moreover the particular shape with "castellations" of the sleeve 31 conveying the mixed water will assure a homogeneous sub-division of the flows towards the tubular path 32, as well as a high sensitivity to variations in flow and pressure. In this way a highly efficacious thermostatic valve is provided whilst maintaining an extremely simple structure of the same valve.

An embodiment of the present invention has been described with reference to the example illustrated.

However, it will be appreciated that variations and modifications may be made to the example described within the scope of the present invention.

CLAIMS

1. A thermostatic mixing valve, the mixing valve comprising:

a hollow body having an inlet for cold water, an inlet for hot water, and an outlet for mixed water in fluid communication with a mixing chamber, the cold and hot water inlets opening laterally towards the mixing chamber in axially spaced positions;

a guide cage inside the mixing chamber and an annular closing member axially slidable in the guiding cage between a retracted position against a first sealing seat where it closes the hot water inlet and an advanced position against a second sealing seat where it closes the cold water inlet;

an axially extending thermostatic actuator and biasing means oppositely acting on the closing member, said thermostatic actuator having a sensitive bulb extending in a path for the mixed water and acting to move said closing member towards one of said sealing seats to keep the mixed water temperature at a constant value when the water conditions at the cold and/or hot water inlets vary and for closing the hot water inlet in the absence of the cold water flow;

the sensitive bulb of the thermostatic actuator being surrounded by a sleeve member of larger diameter defining a tubular path which extends coaxially with the actuator bulb for conveying mixed water from the mixing chamber towards the water outlet;

said sleeve member being movably supported with the thermostatic actuator and the closing member;

said sleeve member comprising a set of radial passages to sub-divide the mixed water flow into a plurality of separated flows between the mixing chamber and said tubular path.

2. A mixing valve according to claim 1, wherein the radial passages for subdividing the mixed water flow are in close vicinity to the sealing seat for hot water.

3. A mixing valve according to claim 1 or claim 2, wherein said radial passages are defined by angularly spaced apart projections provided at an end of the sleeve member facing the mixing chamber.

4. A mixing valve according to any of claims 1 to 3, wherein the total cross-section of the radial passages for the mixed water is in a range which is within ± 10% of the cross-section of the annular passage for the mixed water between the sleeve member and the sensitive bulb of the thermostatic actuator.

5. A mixing valve according to any of claims 1 to 4, wherein the sealing seat for the cold water is provided by a plastics ring and in that the sealing seat for the hot water is provided by a rubber ring.

6. A mixing valve according to claim 5, wherein said rubber ring is surrounded by supporting peripheral surfaces.

7. A mixing valve according to claim 6, comprising a tubular member for supporting the biasing spring of the thermostatic actuator and coaxially extending into the mixed water outlet, said supporting surfaces for the rubber ring being defined by flat surfaces of the guide cage for the closing member, the valve body and said tubular member.

8. A mixing valve according to any of claims 1 to 7, wherein the total stroke of the closing member is between 0.5 and 0.8 mm.

9. A mixing valve according to any of claims 1 to 8, wherein the sensitive bulb of the thermostatic actuator has a cylindrical shape having a slenderness ratio equal to or greater than 3.

10. A thermostatic valve according to claim 1, comprising a sleeve member coaxially extending to the sensitive bulb of the thermostatic actuator, said sleeve having an annular flange provided with axial projections defining said radial passages for the mixed water flow; a tubular member coaxially extending between the sleeve member and the water outlet, said tubular member being provided with an inner annular seat for the resting of the biasing means of the thermostatic actuator, said biasing means being disposed between the inner shoulder of the tubular member and an annular flange of the sleeve member to push the axial projections of the sleeve member against the body of the thermostatic actuator.

11. A thermostatic mixing valve fuel substantially as hereinbefore described with reference to and as illustrated by any of the accompanying drawings.

The Patent Office

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Application No: GB 9820276.5
Claims searched: 1-11

Examiner: Emma McLean
Date of search: 15 December 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F2V (VS25, VV10)

Int Cl (Ed.6): G05D 23/13

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 5 135 163 (CHO) - column 6, lines 17-26 and figs. 3 and 6	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.